# Ecological Impacts of Parasitic Plants on Prairie Communities in the Greater Chicago Region

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## Background

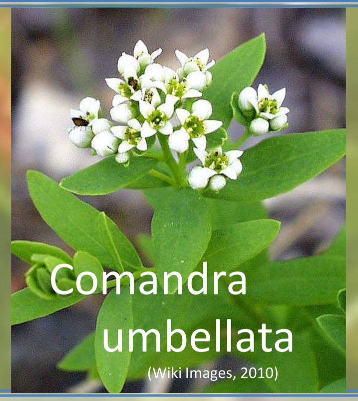
Parasitic plants are species that acquire some or all of their water, carbon and nutrients via the vascular tissue of the host's roots or shoots through connections called haustoria. They are represented by some 4000 species and can be found in most major biomes where they impact host growth, allometry, and reproduction. This in turn leads to changes in competitive balances between host and non-host species which affect community structure, vegetation zonation, and population dynamics. It is argued that parasitic plants can therefore be considered keystone species.

*Castilleja coccinea* is one of many parasitic plant species that occur within the greater Chicago region. In this region it often co-occurs with *Pedicularis canadensis*, and *Comandra umbellata,* which are both hemiparasites. They are ssociated with open prairie and savanna systems and confined to high-quality, remnant vegetation.

Hedberg et al. (2005) found prairie communities with *P. Canadensis* had lower net plant community productivity. This may be due to the reduction in host growth not compensated with an increases in parasite growth. Though the effects of individual parasitic species on variables such as vegetation height are comparatively well known, the potentially confounding effects of multiple, co-occurring parasitic plants have been less thoroughly studied in the context of local ecosystems.

This study aims to investigate whether the effects of parasitic prairie species in the Chicago area are similar to those previously found elsewhere. This will be accomplished by examining the relationship between community productivity (using vegetation height as a proxy) and the presence of local parasitic plant populations. This study will also examine the community level impacts of co-occurring parasitic plant species, and consider the possibility of a facilitative relationship occurring between multiple species.






## Methods

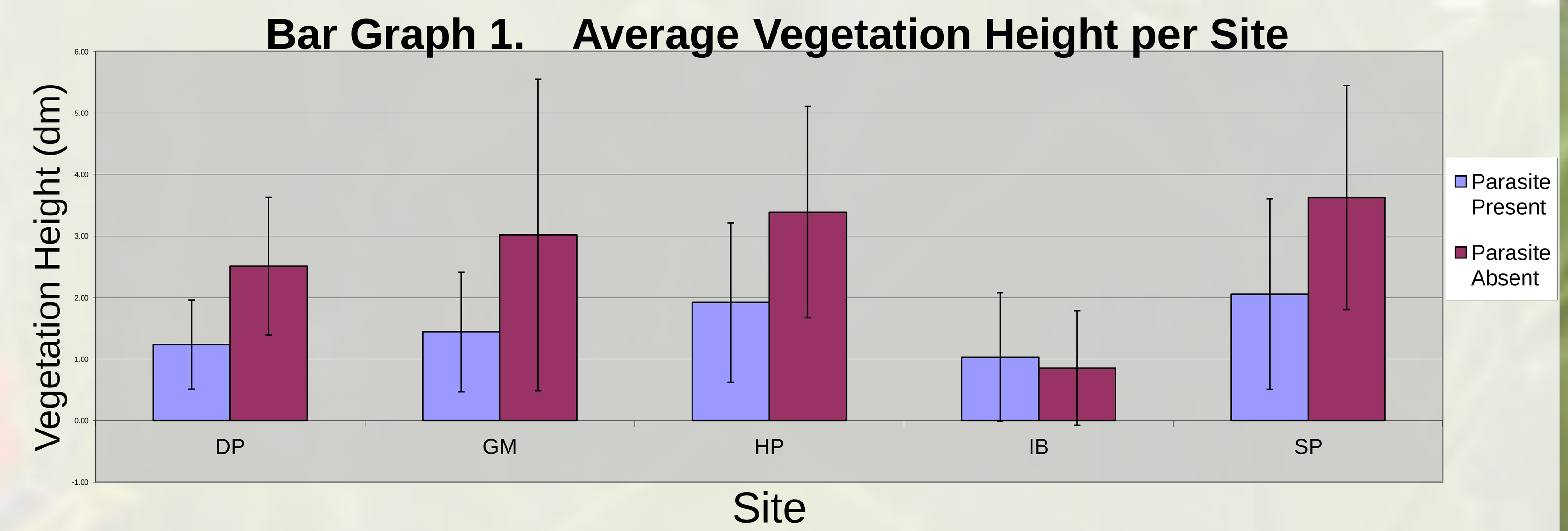
I. Research was conducted at five remnant prairie sites across the Chicago Region.
II. They were selected from a list of sites containing C. coccinea populations used in a study happening concurrently and included sand and mesic prairies.
III. Transects (Fig. 1) were placed through the center of the parasitic plant population.
IV. Transect lengths varied according to the size of the populations (from 17m to 36 m).
V. To sample the way in which absence of parasites influenced the community, each transect was extended by three meters on both ends to gather data points that did not contain parasites.
VI. Along the transect, observations of the presence or absence of *C. coccinea*, *P. canadensis*, *C. umbellata*, as well as the presence of bare ground were made at 20 cm intervals and included the area within a half meter on either side of the measuring tape.
VII. Vegetation height was measured at the midpoint of every meter using a Robel Pole (Figure 2).
VIII. Statistical analyses including generalized linear models to determine significant effects as well as Chi-squared tests of significance. All analyses were performed in RStudio.

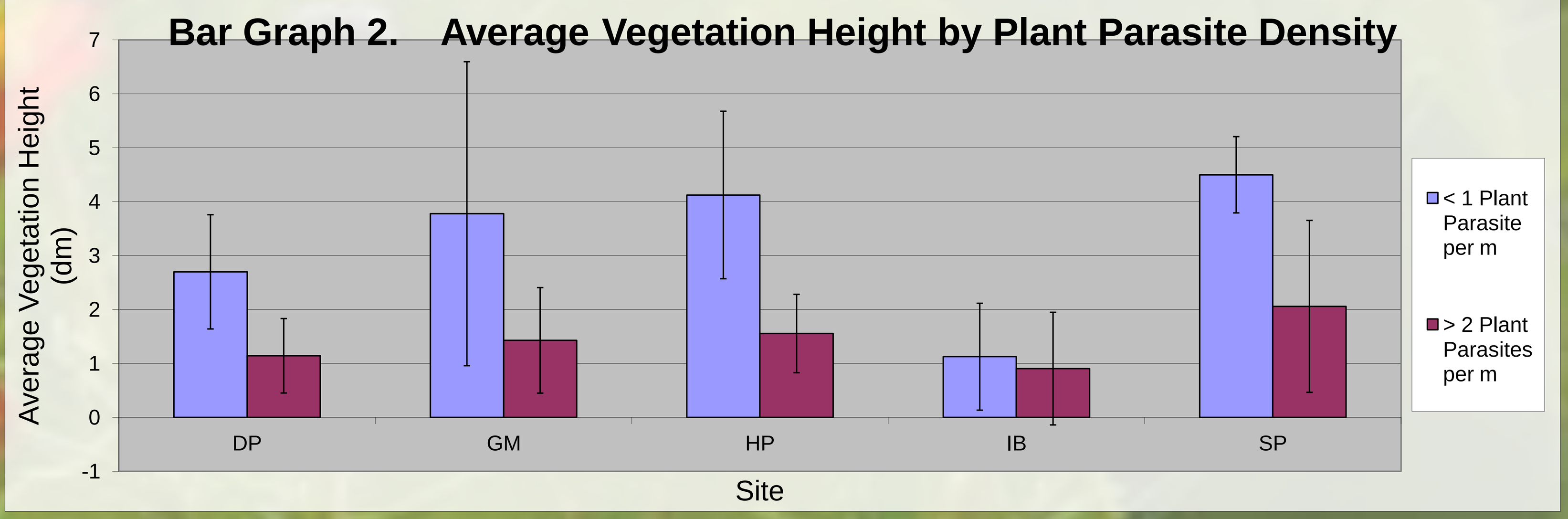
Figure 1.

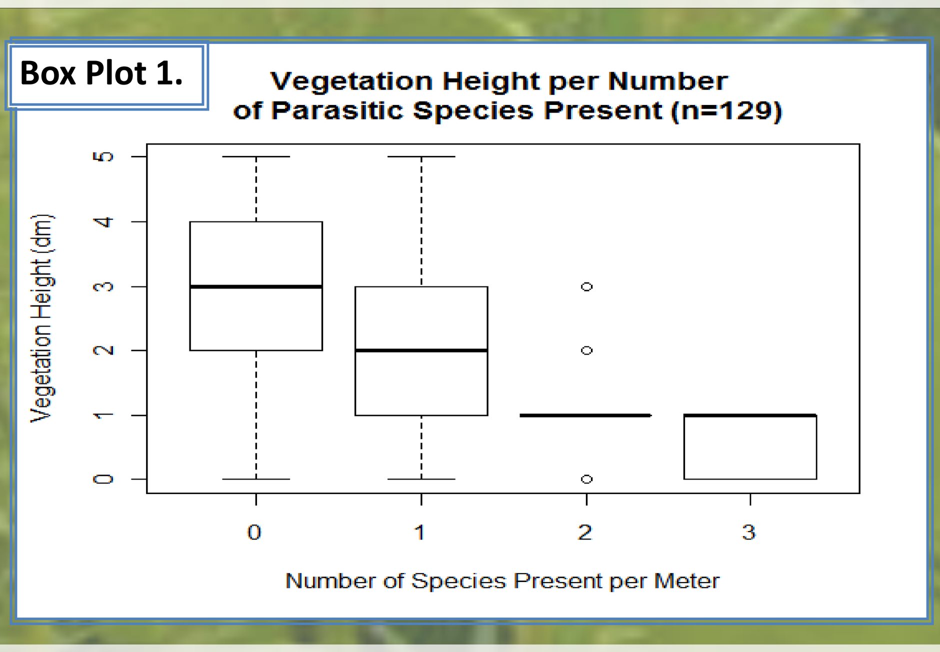
Figure 2.

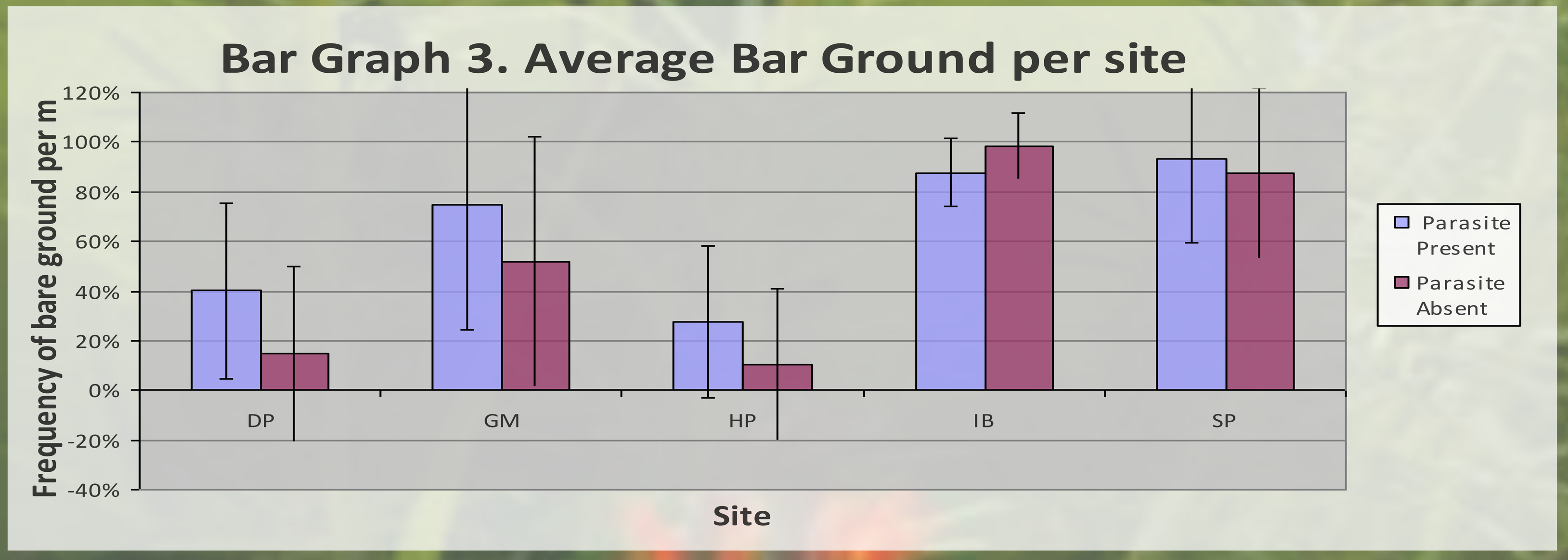
## Results and Discussion

Significant correlates of community structure (vegetation height) were determined using generalized linear models. Parasite density, site, species, and their interactions were all tested through a process of backward elimination starting with a maximal model. Number of species and the interaction between parasitic plant density and site was the best explanatory model for mean vegetation height ($p<0.001$, $n=129$). This model helped define which factors were most important in determining the average height of the vegetation and helped direct further data analysis.




### Effect of Parasites Presence on Vegetation Height (Graph 1)

Vegetation height was shown to be significantly shorter in the presence of plant parasites ($X_{4,1}=11.07$, $p=0.05$). Hedberg et at. (2005) had similar reductions in productivity in their studies of the effects of *P. canadensis* on the tall-grass prairie communities in Illinois. These results support our hypothesis that parasitic plants have important impacts on the structure of the communities in this study.

### Effect of Parasite Density on Vegetation Height (Graph 2)

Vegetation height was also related to the density of parasitic plants ($X_{4,1}=44.51$ $p=0.05$) with the vegetation height decreasing as the density of parasitic plants per meter increased. The interaction between parasitic plant density and site identified in the generalized linear model was likely due to the low density of parasitic plants at Illinois Beach (IB). It is likely a result of early die back of the parasitic plant population prior to the completion of the vegetation survey. The supposed interaction term of parasite density with low vegetation height is thus probably a consequence of our inabilities to identify dormant parasitic plants consistently at each of the sites.

### Effect of Parasite Species on Vegetation Height (Box Plot 1)

We found that vegetation height related to the number of parasitic plant species present ($X_{4,1}=38.81$, $p=0.05$) This may indicate that changes in the community structure associated with one parasitic plant can benefit the presence of other parasitic plant species in the community. This would suggest that there is a facilitative relationship between parasitic plant species. This study was unable to establish facilitation but did identify some characters (vegetation height (competition) or bare ground (recruitment)) which could be tested. We are currently analyzing community data to determine if multiple species co-occurred more frequently than not.

### Effect of Parasite Presence on the Freq. of Bare Ground (Graph 3)

We also found that bare ground was positively related to the presence of plant parasites ($X_{4,1}=62.22$, $p=0.05$). This could possibly have been related to the reduction in local productivity associated with the presence of plant parasites. Bare ground is often more common in communities were size is limited by stressful conditions rather than resources (where competition is more important). Our results suggest that plant parasitism is resource limiting in its role as a stressor within the plant community.

## Conclusion

- **There is decreased productivity in local ecosystems associated with parasitic plants.**
- **The observed decrease in community productivity is inversely related to the density of parasitic plants per area.**
- **The observed decrease in community productivity is inversely related to the number of parasitic plant species per area.**
- **The frequency of bare ground per area is positively correlated with the presence of parasitic plant species.**

## References

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